1939

A study of the value of physics note books as contrasted with substitute activities.

William J. Clancy
University of Massachusetts Amherst

A STUDY OF THE VALUE OF PHYSICS NOTE BOOKS AS CONTRASTED WITH SUBSTITUTE ACTIVITIES

CLANCY - 1939

A STUDY OF THE VALUE OF

PHYSICS NOTE BOOKS AS

CONTRASTED WITH

SUBSTITUTE

ACTIVITIES

BY

WILLIAM J. CLANCY

THESIS SUBMITTED FOR THE DEGREE OF

MASTER OF SCIENCE

MASSACHUSETTS STATE COLLEGE

AMHERST, MASS.

1939

TABLE OF CONTENTS

TABLE OF CONTENTS (continued) PAGE

TABLE OF CONTENTS (continued)

LIST OF TABLES

LIST OF TABLES
(continued)

LIST OF TABLES
(continued)

PART 1

INTRODUCTION

INTRODUCTION

This thesis attempts to determine whether or not the educational value of the physics experiment as classroom technique may be increased by other methods than by the use of the laboratory notebook or workbook.

Why this subject : -

Questions frequently asked these days among High school teachers are : - "What is the pupil really getting from the routine notebook and workbook preparation ?" "Is the preparation of the physics experiment notebook and workbook returning educational value commensurate with the original purpose ? " "Is the pupil's scientific viewpoint enriched by the present notebook and workbook presentation ? " "Isn't there a better way of registering these scientific facts so that the significance will be more premanent ? "

These and similar questions so often presented have prompted the writer to attempt a study to determine the answers to the inquiries and if possible to make recommendations in the light of the findings.

PART II

CERTAIN ATTITUDES

PART II

CERTAIN ATTITUDES

The attitude of teachers

Generally speaking the evolution of educational forms and practices follows a general pattern from year to year and from generation to generation. Practices are adopted and discarded as experience sorts the good from the bad, success from failure. Some of these practices, however, escape the nod of approval or scorn of rejection, but go on unnoticed in the engulfing currents of the status quo. In such status at the present time is the use of physics notebooks and workbooks.

There are some teachers who remain firmly embedded in the old way of doing things and are reluctant to make any change. Custom has enslaved them to certain definite practices which progress has found too adamant to change.

Other teachers recognize the advantage of prudent revision of our methods but do nothing about it for fear of criticism.

there are others who openly disagree with the present practices. They see that not only can progress be achieved but that a great deal of wasted time may be saved.

These generalizations indicate that the science teachers are not all in agreement concerning the present physics set up of experimental notebooks and workbooks.

H.S.Shelton has this to say:-

> "Some how or other the modern science teaching has proved to be dead and nearly as much divoced from modern life and thought, as the old classical teaching ."Something is wrong ." *

Many teachers point out that too much time is consumed in the mechanics of preparation for the laboratory period thereby wasting valuable time which could be devoted to a more profitable use.

In this respect Colvin writes:-

> "It has been the writer's experience that many classes in laboratory science are woefully slow in getting started.......One of the worst classes that I ever observed both from stand point of order and effective instructions was a class of this kind."**

Another charge by teachers is the fact that too many experiments include the unnecessary task of copying material from guide sheets thus robbing the pupil of original thinking.

* H.S.Shelton - New Type of Science Teaching
Contemporary Rev. P 599 Mar. 1936

** Cölvin--Introduction to High School Teaching
CH IV P63

Again Colvin points out :-

"The laboratory exercises are often quite formal........The pupil has no genuine desire to discover new facts or principles and he goes through a series of careful instructions contained in a laboratory manual in a mechanical way......He may be interested in the manipulation of his material but a genuine scientific curiosity is for the most part lacking."*

From other quarters come impressions regarding workbooks. Pearle Ethel Knight writes:-

"Now just what is the educational value of this piece of work ?.......It does represent industry for it took hours of painstaking work; but if industry is spent in vain how ought it to be reckoned ? "

Fred W. Wolcott says;-

"Investigation with the complaints of teachers soon convinces one that there are many serious provlems arising from the use of the workbook, that without a wise judgment upon the applicability of their contents, they are often more harmful than good, and that the fundamental principles which the book work technique involves are not often clearly understood." **

Also Cecillia J. Allen says:-

" I should like to say in ending that the workbook........proved superior to the text. Its failing is that it is still too much like the child of its nearsighted and pedantic parent. Let the workbook grow as artistic in its teaching processes as it is in its workmanship and it will come nearer to meeting its gloriously pragnatic claims ." ***

* Colvin---Introduction to High School Teaching
CH III P 33

** Fred G. Wolcott--Problems of the Workbook
Eng. J. Sept 33 P 574

***Cecillia J. Allen--So This is the Workbook!
Eng. J. May 33 P 380

George A. Motter, in school Perview states: (in conclusion)

> "It is concluded that the work book fails on the basis of the data derived from this experiment, to live up to its principle claim to superiority of objectivity ." *

Another complaint advanced in opposition to notebook writing is that the teacher utilizes too much time in checking books and too little time in actual class work . Supporting this contention, Colvin writes,

> "Of course the chief objection to such procedure (note book writing) is the amount of time consumed by the teacher in inspecting and correcting the notes. Consequently this form of instruction can be used only in a limited degree." **

Some teachers hold fast to the idea that properly kept notebooks are essential to subject matter development. To eliminate notebooks for some substitute procedure is endangering the possibility of clinching physical principles and methods.

> "It is my opinion that there has not yet been presented any substitute that will adequstely take the place of the present method of preparing experiment notebooks ". ***

* George A. Motter - Teacher Assignment vs Workbook
School Rev. Jan.'39

** Colvin Introduction to High School Teaching
CH XI P.320

*** Alfred R. Lincoln, Science Dept
Technical High School
Springfield,Mass.

And what is the opinion of those teachers who are on the firing line actually handling these notebooks every day ? What do they have to say about the status of the experiment notebook and the workbook ?

The following points have come to light from those closest to the picture, and is a summation of personal opinion by many teachers, expressed to the writer orally.

Few students today will sit down and write in notebooks a summary of an experiment in an intelligent way. This may be acceptable from the point of view of a research worker who is passing on to posterity important records but to expect a group of modern youths to analyze, estimate, sort, and classify a group of unassorted facts in an intelligent manner seems to be expecting too much.

With single period classes and ever growing ones, the pupils do not have time to write up their findings properly. Because of this lack of time, individual experiments are rapidly being superceded by the demonstration, thus making it even more difficult for the pupil to grasp the real meaning of the principles involved.

Economical curtailments in equipment and supplies have greatly handicapped, in very recent years, the orderly process usually found in the ideal laboratory.

Because of this lack of time afforded, due to single period laboratories, many pupils do their work outside where copying is apt to be in order and where little attention is paid to the experiment and the object for which it was performed.

With the degree of ability among the students, so variable in most of the classes a small portion may offer a satisfactory report, while the others either fail or copy outside.

Many of the teachers interviewed say,

> "What is the value educationally of requiring the experiment of demonstration be written up by the pupil " ?
> "What does it amount to " ?
> "Why cannot the time used in writing a report of the experiment in notebooks be utilized to better advantage in some other way " ?
> "Who is going to say what this way will be "?

Attitude of the Colleges

For many years a student was required to present a satisfactory notebook as part of the requirement for admission to college. To-day, the vast majority of colleges and universities are no longer demanding such evidence, at least in individual form. They require, however, that the candidate for admission offer concrete evidence from his secondary school that he has completed a certain number of experiments in a satisfactory manner.

This change on the part of the colleges and universities in respect to notebooks was due to the following causes:

1st. Ownership cannot be guaranteed or relied upon. It has been discovered at most of our larger colleges that this unethical practice forced the adminstrators to take the step they did.

2nd. Candidates for admittance have lost their notebooks and the secondary school had no record to offer in lieu of the notebooks.

3rd. Notebooks were so poorly done that the colleges threw the responsibility back into the laps of the secondary schools.

> "In 1931 Wesley issued a rather clear cut challenge to students of education to investigate scientifically the problem of the value of any and all workbooks. This challenge has, apparently, been almost entirely ignored : the writer was able to find the published report of but one controlled experiment to determine the value of the Social-Science workbook." *

In view of the disturbing doubt of the value of the notebooks as part of the required work in physics classes it has seemed of value to education to attempt an impartial controlled test of the matter. This thesis is the result.

* Edgar Bruce Wesley , "Workbook in the social studies." Historical Outlook XXII Apr. 1931 151-53

SUMMARY

From the preceding comments, statements and facts we may, with accuracy, deduce that something is wrong with the present method of notebook and workbook procedure in the laboratory. Educators and teachers both inside and outside the laboratory see that a problem is awaiting a solution. All are looking toward the horizon with expectancy for the new hope that is bound to come.

PART III

AVAILABLE RESEARCH WORK

AVAILABLE RESEARCH WORK

The writer found no works available from the standpoint of scientific investigation. *

There are but two treatises found which had any direct bearing on this subject and these dealt merely with factual learning in contrast with the workbook and oral instruction. The following statements are presented to show how little has bean done along these lines.

Cressman ** performed an experiment to compare the values of the workbook method and the oral-instruction method in teaching citizenship and conduct toa group of seventh grade pupils. He found that the notebook method was slightly but not significantly superior to the oral-instruction method and he concluded that the results indicated no significant advantage over oral instruction.

Nelson***conducted an experiment from which he concluded that for teaching of civics to pupils of Grades XI and XII the workbook has no significant advantage over an oral-instruction method .

* See statement in summary Part II Page 9 by Edgar Bruce Wesley

** Elmer W.Cressman, "Workbook vs Oral Instruction" Journal of Educational Sociology VII Dec 1933 250-253

*** Clayton L. Nelson, School Rev. XLVI(Jan. '38 17-31) The Development and Appraisal of workbooks in the Social Sciences. R.M. Tyron (Cited)

The results of these two experiments have stood alone to refute the testimony of many enthusiastic indorsements by the workbook indorsements necessarily based on opinion and belief.

To corroborate these findings and to further substantiate the facts involved, sources constantly active in secondary school projects were asked to offer their opinion on the work done in this field. The replies received from the National Education Association, Washington, D.C., and the Cooperative Study of Secondary School Standards, Washington, D.C., are herewith attached.

Both bear evidence of the frugality of research done on the subject matters which this thesis attempts to cover.

Cooperative Study of Secondary School Standards

EXECUTIVE OFFICE
744 JACKSON PLACE, WASHINGTON, D. C.

WALTER CROSBY EELLS
COORDINATOR

February 8, 1939.

Mr. William J. Clancy,
75 Avon Place,
Springfield, Massachusetts.

Dear Mr. Clancy:

I am sorry to say that our Study has not collected any information relative to the value of physics notebooks in secondary education.

Very truly yours,

W. C. Eells

Walter C. Eells
Coordinator

WCE:wr

NATIONAL EDUCATION ASSOCIATION OF THE UNITED STATES
1201 SIXTEENTH STREET, N. W., WASHINGTON, D. C.

February 16, 1939

Mr. William J. Clancy
Technical High School
Springfield, Massachusetts

Dear Mr. Clancy:

In response to your letter of January 31, I am writing to say that the Research Division has compiled no information relating to your thesis subject. However, I am listing below some references on notebooks which have been copied from the Education Index, published by the H. W. Wilson Company, New York City:

1. Stolzenbach, Margaret. "Home Economics Notebooks: An Evaluation of Their Worth as a Teaching Device." Practical Home Economics 14: 338+; November 1936.

2. Eckert, George Walter. "Lecture Notebook for Freshman Chemistry." Journal of Chemical Education 13: 431; September 1936.

3. Roy, Margaret. "Notebooks as Projects in a History Course." Social Studies 28: 111-15; March 1937.

4. Harper, Charles Athiel. "Notes and Note Taking in High School Social Studies." Social Studies 28: 172-73; April 1937.

5. Peterson, George W.; and Douglass, H. R. "Published Workbooks versus Pupil-Made Notebooks in Ninth-Grade General Science." School Review 43: 606-13; October 1935.

6. Knight, Pearle Ethel. "How Valuable Is Mary's Notebook?" English Journal (H. S. Ed.) 22: 57-59; January 1933.

7. Woods, Roy Cleo. "Notebook as an Educational Device." Peabody Journal of Education 12: 118-19; November 1934.

14

8. Crumby, Mabel G. "Our Children Use Notebooks." Sierra Educational News 30: 39; September 1934.

9. Segerblom, Wilhelm and others. "Symposium on Laboratory Notebooks, Records, and Reports." Journal of Chemical Education 10: 403-14; July 1933.

10. Ballew, Amer M. "Notebook Work in Biology and Training in the Scientific Method of Thinking." School Science and Mathematics 31: 822-26; October 1931.

It occurs to me that the following enclosures may be of some interest:

1. "References on Science," Research Division, July 1938.

2. "References on Workbooks," Research Division, September 1935.

Cordially yours,

Frank W. Hubbard

William G. Carr
Director

Frank W. Hubbard
Associate Director, Research Division

RGW:p
Enclosures

PART IV

SETTING THE PROBLEM

SETTING THE PROBLEM

The Problem.-

Since there is a necessity, then, for a study that will attempt to evaluate the position of the notebook in the physics laboratory, the following plan has been prepared to measure the results of the work of those pupils who use the notebook and other pupils who have employed a substitute activity.

Are pupils apt to learn more if the time used for notebook writing is substituted for some other activity ? If the results show superior accomplishments for those who use the notebook, then the claim of those in favor of its use would be upheld. However, if the results indicated that those who use the substitute plan gave significant evidence of superior achievements, then the claim made for the notebook and workbook would be greatly minimized. The measurement of the teaching effect of these two methods is the object of this experiment.

Scope and Limitations.-

This experiment has as its objective the teaching effect of laboratory notebook construction versus some other educational activity.

The study is limited to secondary education and may include college prepartory as well as general students of physics.

Definition of terms.-

The term " experiment" means those laboratory exercises constructed either in whole or in part by the student. The term "demonstration" refers to the experiment performed by the teacher and observed by the pupil. "Notebook" is the written individual record of the experiment on demonstrations compiled by the student. By the term workbook is meant an especially prepared book with loose leaves or detachable sheets containing statements partially complete or places where the pupil must insert a word to complete a statement. There are many types of these workbooks on the market and the problem offered may include , completion tests, true and false tests, matching tests, etc. "Other activities" may include such features as :

1. The Solution of Typical Problems.
2. Making of Laboratory Apparatus.
3. Making of Scientific Instruments.
4. Membership in Science Club.
5. Home Workshop.
6. School Workshop.

PART V

PROCEDURE

THE PLAN

The plan called for two groups, namely: the control group and the experimental group. One of these groups was called upon to omit the usual notebook while the other group carried on in the usual manner employing the conventional notebook.

The same experiment of demonstration was given to both groups on the same day. For those using the notebook a mimeographed guide sheet of directions was given to each pupil. When completed the experiment was expected to have a title, an object, a list of materials or apparatus, a neatly drawn sketch, a story of the experiment in the pupil's own words, proper calculation of the given problem and a conclusion.

These experiments were examined for correctness, neatness and completeness. If unsatisfactory, the work was rejected to be done over again. Individual assistance was available after regular school session.

The experimental group substituted typical problems in place of the notebooks. Problems dealing with the principles involved in the experiment were passed out to this group. The teacher was available at all times during the period for any assistance desired. At the end of the period the papers were collected. These were returned the next day with corrections and notations.

The incorrect problems were to be returned again for inspection. Pupils still showing evidences of slowness were asked to report for further instructions.

From time to time general routine problems dealing with the subject matter and experiments were given each group for homework.

The textbook was the same for all pupils and the discourses and discussions followed the same lines in every case.

Ten tests covering ten experiments were planned for both groups. These tests were given to all pupils on the same day. Absentee pupils were given the same test as soon as possible upon their return.

(See tests -Appendix)

EQUATING AND HANDLING THE PUPILS

The writer had three physics I classes at Technical High School, Springfield, Mass. Permission was obtained from Principal, Major Burton A. Adams, to use these three classes in the proposed experiment. The sizes of these classes were 33, 29 and 29 . They consisted of all boys and no repeaters. The classes were taken just as they came with no sorting, balancing or homogeneous grouping. For classes see Tables 1, 2, and 3. The groups were then equated by one standard.

The I.Q. rating for each pupil was obtained from the office records.

It was found that twelve pupils had no I.Q. record. Dr. Verne B. Ross, Ass't Principal, together with the writer tested each pupil for his Intelligence Quotient. The method used was the same as that of the psychological laboratory. The I. Q. range varied from 133 to 81 .

Pairings were then made of the two groups according to the following I.Q. classifications:

110 to 115

105 to 110

100 to 105

95 to 100

90 to 95

80 to 90

The experimental group with the notebooks and the control group without the notebooks were paired according to I.Q. rating. See Table VI .

The sum total I.Q. for the experimental group was 2555 for the control group 2536 a difference not significant because I.Q. rating is not considered an accurate measure.

All pupils had the same teacher so that there was no teacher difference with which to contend.

The general school factors were the same for both groups. Supervision opportunities, etc., were similar for all pupils.. All pupils used the same textbook while notebooks were available at all times. All pupils had equal opportunity for make-up work and time was made available for all to seek assistance.

The notebook, then, was the only variable factor.

GRADUATE QUESTIONNAIRE

A questionnaire was sent out to the graduates of the Technical High School for the purpose of finding out what personal value was placed upon the physics notebook and to determine, if possible, what use these books have been to the individual student after getting out of high school.*

Two hundred postcards were distributed to male graduates only. Of this number one hundred and seventy three responded; twenty one failed to reply; while one blank was returned. The number of replies totaled 88%.

The range of graduate years extended from 1910 to 1938 giving a very faborable spread.

There was an even distribution of replies from college preparatory and general students namely ;

89 of the former and 82 of the latter

with 2 applied art students. (see Table P.24)

*Questionnaire P 23

The second question, "Do you still have your physics notebook?," showed that 47.9% still had possession of them, while 52% did not. These figures were quite well balanced.

The third question , " Have you ever had an occasion to use your notebook ? ", showed a much greater divergence. 17.9% claimed that they did have occasion to refer to them, while 71.5% did not. 11.5% failed to specify.

This revelation seems to be significant and is apparently the general trend of the ultimate fate of notebooks.

The fourth question , " In what way ?", referring to question three, found that only 11 out of173, or .06% gave a specific reply. This seems to show further a tendency of the notebook to fade out of the picture very soon after graduation.

The last question , " Would you suggest a substitute for the physics notebook ? ", showed even a less response, for only .03% or 6 replies indicated a willingness to suggest a substitute . This was expected in a way because the graduates contacted are not teachers and less apt to weigh these values. The six responses, however, were quite timely and very commendable.

To the writer this questionnaire, while not too comprehensive, does point out to a significant degree what the real value of the notebook is. It helps to measure the results of the main plan of attack and is indicative of trends which will help in the final analysis in summing up the results. It definitely points out that the notebook is soon forgotten after it has been completed with little carry over values.

GRADUATE

QUESTIONNAIRE

Dear Techite:

The information asked for on this card is to be used in the construction of a Thesis. The sender appreciates your kindness. Please drop in mail.

1. Your class .... 19 C.P. on Gen.
2. Do you still have your physics experiments ....
3. Have you ever had an occasion to use them ....

Answer Yes or No.

4. If yes; in what way?
5. Would you suggest a substitute for experiments?

Thank you W. J. Clancy

This questionnaire was issued to Springfield Technical High School graduates.

It includes the classes of 1910 to 1938

Not every class between these years was represented.

See Table Page 25-26

TABLE I

QUESTIONNAIRE DISTRIBUTION

YEAR	NO RESPONSES	CLASSES C.P.	GEN.	AA
1910	1	1	0	0
1913	1	1	0	0
1914	1	0	1	0
1916	1	1	0	0
1918	2	2	0	0
1919	1	0	1	0
1920	3	1	2	0
1922	4	2	2	0
1923	2	0	2	0
1925	4	1	3	0
1927	4	1	3	0
1929	10	6	4	0
1930	12	7	5	0
1931	9	4	5	0
1932	18	14	4	0
1933	20	9	10	1
1934	16	8	8	0
1935	18	7	10	1
1936	15	9	6	0
1937	17	10	7	0
1938	14	5	9	0
	175	89	82	2

NUMBER OF CARDS SENT OUT ------------195
REPLIES -----------------173
BLANKS REDEIVED---------- 1
UNANSWERED -------------- 21 195

% REPLIES - 88%

TABLE II

CLASSIFICATION OF QUESTIONNAIRE

QUESTIONS	YES	NO	TOTAL	STATEMENTS
1. DO YOU STILL HAVE YOUR PHYSICS NOTEBOOK ?	83 47.9%	90 52%	173	
2. HAVE YOU EVER HAD AN OCCASION TO USE YOUR NOTEBOOK ?	31 17.9%	142 71.5%	173	20 CASES FAILED TO SPECIFY 11.5%
3. IN WHAT WAY ?	11 .06%	162 99.94%	173	1-REVIEW 1-REFERENCE (GENERAL) 2-RADIO 1-TEACHING GENERAL SCIENCE 2-REFERENCE COLLEGE PHYSICS 1-EVENING SCHOOL 1-CORRESPONDENCE SCHOOL 1-AERONAUTICS 1-FOR MAKING A SYSTEM OF PULLEYS
4. WOULD YOU SUGGEST A SUBSTITUTE FOR EXPERIMENT NOTEBOOKS ?	6 .03%	167 99.97%	173	1-WRITE A THEME ON EACH EXP. 2-TIE-UP WITH OUTSIDE HOBBY 3-MORE WORK SHOULD BE DONE BY THE STUDENT 4-MORE PRACTICAL APPLICATION OF PHYSICS IN HIGH SCHOOL 5-MORE MOTION PICTURES WITH ANIMATED DRAWINGS 6-TIE-UP WITH SHOPS

TABLE III

TEST SCORES NAME	IQ	GROUP A TESTS 1	2	3	4	5	WITH NOTEBOOKS 6	7	8	9	10	TOTAL SCORE
ALBANO MICHAEL	120	70	63	65	60	70	80	75	50	40	40	614
ALLARD ED.	108	40	50	80	55	50	85	70	50	50	50	580
ALLEN GILBERT	97	30	60	50	35	20	76	40	50	50	50	461
BANDOSKI ALEX	101	76	84	60	75	20	70	74	65	60	60	645
BARROWS RICH.	96	80	71	60	55	40	89	80	80	80	80	715
BILODEAU ART.	109	25	40	60	55	70	72	30	60	60	65	537
BONACHER ED.	91	48	50	38	55	50	60	50	50	55	60	516
BURGEL WM.	110	100	50	90	45	40	70	45	55	60	60	615
BRADLEY HARRY	97	54	60	95	50	20	78	70	70	60	65	572
CAVANAUGH JAS.	121	75	78	80	55	82	88	90	85	75	75	783
CLARK WARREN	99	0	13	30	35	25	40	40	50	55	60	348
DALTON WILLIAM	110	48	49	60	50	40	75	90	50	50	50	562
DASSATTI GINO	106	40	58	55	60	20	82	70	60	60	60	565
DOWNER HENRY	96	20	66	40	55	25	74	60	65	60	50	515
FOSTER ROBERT	110	40	60	50	50	40	40	85	70	70	75	580
GRACHI STANLEY	109	100	73	65	70	80	90	60	60	65	50	713
GUIDETTI ROBT.	111	60	53	28	60	45	75	65	50	50	40	528
HERNE RALPH	87	30	75	60	40	70	70	78	75	75	72	645
HOPE WILLIAM	95	54	85	33	30	40	80	80	50	50	65	567
KINIRY JAMES	88	40	28	58	45	60	70	90	60	50	40	541
* LAWLER JAMES	115	0	50	25	15	50						
LEACH FRED	110	20	63	40	55	30	86	75	70	70	80	588
LYNCH WALTER	96	40	63	45	45	0	70	0	40	40	30	373
NEWINGTON VERNON	111	60	43	70	55	40	60	50	55	40	50	523
NIEC HENRY	96	20	45	50	70	40	82	65	70	70	70	582
NOLAN ROBERT	110	60	51	53	45	20	50	40	75	70	70	534
RHEUME ROGER	106	70	58	72	55	20	75	60	60	60	70	600
ROBERTS VENDAL	105	48	53	65	40	0	60	0	50	40	40	396
* RYAN JOHN	106	50	41	60	60	0	50	92				
SALIER UGO	93	20	38	40	50	20	40	30	40	40	30	348
SWANSON ELMER	98	65	70	80	75	50	90	90	80	85	85	770
THOMPSON RICH.	133	71	55	50	50	10	86	55	60	50	60	547
WATSON BRUCE	96	20	53	30	75	20	70	65	60	60	60	513

* LAWLER JAMES
RYAN JOHN — RECORDS INCOMPLETE NOT USED IN CORRELATION.

TABLE IV

TEST SCORES — GROUP B TESTS WITH NOTENOOKS

NAME	IQ	1	2	3	4	5	6	7	8	9	10	TOTAL SCORE
AYERS JOHN	107	32	38	45	40	75	0	50	60	40	38	418
BERNARD RUDOLPH	106	40	50	35	60	30	70	40	56	42	50	473
BUFFINGTON CHAS.	108	18	20	15	25	30	70	50	75	65	70	438
CARNEY LORINA	106	40	40	35	50	40	65	50	60	62	60	502
DESNOYES RENE	93	20	40	45	50	50	70	60	58	68	65	526
DONOGHUE DAN.	108	50	56	70	90	50	88	80	60	65	50	659
EVANS ROBERT	92	30	61	58	85	45	90	70	85	86	90	700
GALARNEAU RICH.	90	30	13	10	20	0	65	0	40	45	30	253
GEOTSIS FABIAN	101	20	43	38	35	20	25	40	40	50	65	376
GRABIEC STEPH.	121	80	71	75	60	40	90	95	90	90	92	783
HOAR EDMUND	98	20	50	33	55	50	75	50	70	75	70	548
KAROWSKI FRANK	114	80	35	50	45	25	80	70	65	60	70	586
LATINO JOSEPH	97	40	65	58	85	60	70	75	80	84	85	702
LINDWALL CARL	118	30	43	58	80	50	65	50	76	78	75	605
MAROO HENRY	85	20	48	23	75	0	70	45	65	60	72	478
MERTON JOSEPH	94	0	31	10	45	0	30	0	50	45	40	251
WILLINGTON WES.	96	0	53	35	40	40	65	70	75	72	78	528
MITKOSKI JOS.	97	20	56	65	40	0	50	50	45	50	40	416
NEWTON RICH.	99	20	68	68	35	0	50	0	70	70	70	461
OLSON ROBERT	93	40	41	66	75	0	70	80	70	75	70	587
OUTHUSE ART.	1 02	24	58	53	50	0	76	50	72	70	70	523
REECE GUY	103	20	36	50	75	0	40	0	0	0	0	221
ROGERS DONALD	107	20	85	50	50	40	60	60	85	90	95	675
RUDDERFORTH ENG.	117	40	46	40	45	0	60	0	50	50	40	371
SODERMAN HAR.	105	40	21	53	54	0	75	50	75	72	70	510
STAMPLE RICH.	128	10	53	67	60	0	80	40	65	60	70	505
STAUNTON DON.	103	20	66	53	40	25	58	70	80	70	75	557
SULLIVAN HEN.	88	0	66	45	50	40	70	40	50	60	30	451
WEINSTEIN HAR.	97	80	78	55	35	55	80	75	75	75	80	688

TABLE V

TEST SCORES GROUP C WITHOUT NOTEBOOKS

NAME	IQ	TESTS 1	2	3	4	5	6	7	8	9	10	TOTAL SCORE
ASHER GEORGE	92	40	59	60	60	55	70	50	75	70	80	619
BERG CHARLES	114	60	44	55	20	50	60	30	70	70	85	544
BEWSOE EMERY	100	0	52	80	45	0	50	30	60	60	60	427
BOUCHER ARTHUR	98	0	48	25	50	50	80	60	65	70	50	496
* BRITTAIN EDWARD	106	40	50	45	50	60	71					
BROOKS WILLIAM	92	70	86	60	50	50	95	65	75	75	80	706
BUCKLEY JAMES	81	50	48	55	50	60	80	40	70	72	75	600
BUONICONTI JOS.	100	20	76	55	70	30	80	50	80	76	20	557
CAISSE NORMAN	92	30	35	20	40	45	70	40	50	60	60	450
DEVINE ROY	107	80	80	98	35	85	95	80	82	85	85	805
DICKSON GEORGE	102	30	68	40	55	60	50	40	50	60	40	493
FIELD JUNE	110	80	78	95	35	85	90	85	90	92	90	825
* FRAPPIER RAYMOND	107	0	28	10	40	20	80	0				
FURKEY RICHARD	103	50	91	65	60	70	70	40	70	60	65	641
HARRINGTON WM.	103	50	52	55	60	80	74	70	80	75	60	607
HEDIN CARL	111	70	86	85	80	95	100	95	95	95	95	898
LAWSON WALTER	103	40	55	75	65	0	76	75	75	75	80	616
LEWIS RICHARD	99	20	63	70	70	0	70	90	80	84	70	617
MASQUE WESLEY	106	76	78	70	45	80	90	50	85	90	90	754
MCCARTHY LAWRENCE	113	40	77	55	45	40	0	50	70	70	60	507
MOTLOWITZ NICH.	110	100	96	85	100	100	100	100	100	100	100	981
PLUMADORE WM.	86	20	65	95	55	40	75	85	75	80	90	680
RIDDLE RAYMOND	122	80	38	70	75	90	90	50	72	80	85	730
ROBINSON HAROLD	108	0	40	0	50	50	50	0	50	65	45	350
RUEL KENNETH	107	0	75	65	70	70	0	75	75	75	70	570
SITEK ROBERT	102	70	66	65	80	60	72	60	76	72	65	686
TOURTELOTTE ROBT.	95	50	71	65	70	70	75	60	75	75	75	716
VEY EDWARD	106	0	51	45	60	50	40	80	65	68	40	499
ZEIGLER TEDDY	96	0	83	55	24	55	50	0	50	45	30	435

* EDWARD BRITTAIN
RAYMOND FRAPPIER RECORDS INCOMPLETE NOT INCLUDED IN CORRELATION

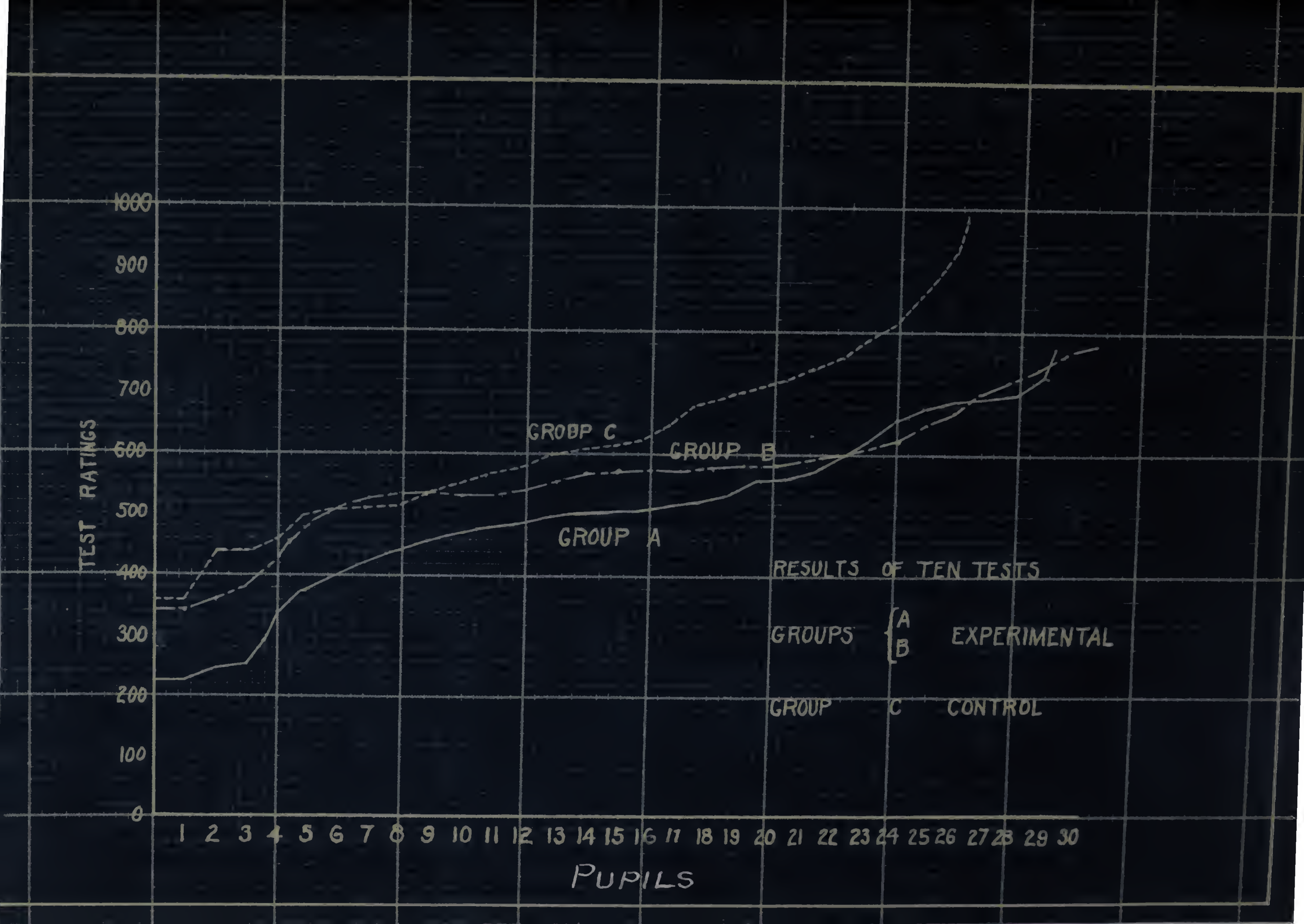

TEST RATINGS
1000
900
800
700
600
500
400
300
200
100
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
PUPILS
GROBP C
GROUP B
GROUP A
RESULTS OF TEN TESTS
GROUPS A B EXPERIMENTAL
GROUP C CONTROL

TABLE VI

IQ PAIRINGS

EXPERIMENTAL GROUP (WITH NOTEBOOKS) NAME	IQ	IQ	CONTROL GROUP (WITHOUT NOTEBOOKS) NAME	IQ
		110-115		
L.C.	118		B.B.	114
K.R.	114		H.C.	111
B.W.	110		F.J.	110
D.W.	110		M.L.	113
G.R.	111		M.N.	110
N.R.	110		D.R.	110
		105-110		
A.J.	107		V.E.	106
B.C.	108		M.W.	106
A.E.	106		R.H.	108
D.G.	106		R.K.	107
		100-105		
G.F.	101		B.E.	100
O.A.	102		B.J.	100
R.G.	103		D.G.	102
S.H.	105		F.R.	103
R.W.	105		L.W.	103
S.D.	103		S.R.	102
		95-100		
B.R.	96		B.A.	98
D.R.	96		L.R.	99
C.W.	99		Z.T.	96
		90-95		
D.R.	93		A.G.	92
E.R.	92		B.W.	92
M.J.	94		C.W.	92
S.U.	93		T.R.	95
		80-90		
M.H.	85		B.J.	81
S.H.	88		P.W.	86
	2555			2536

TABLE VII

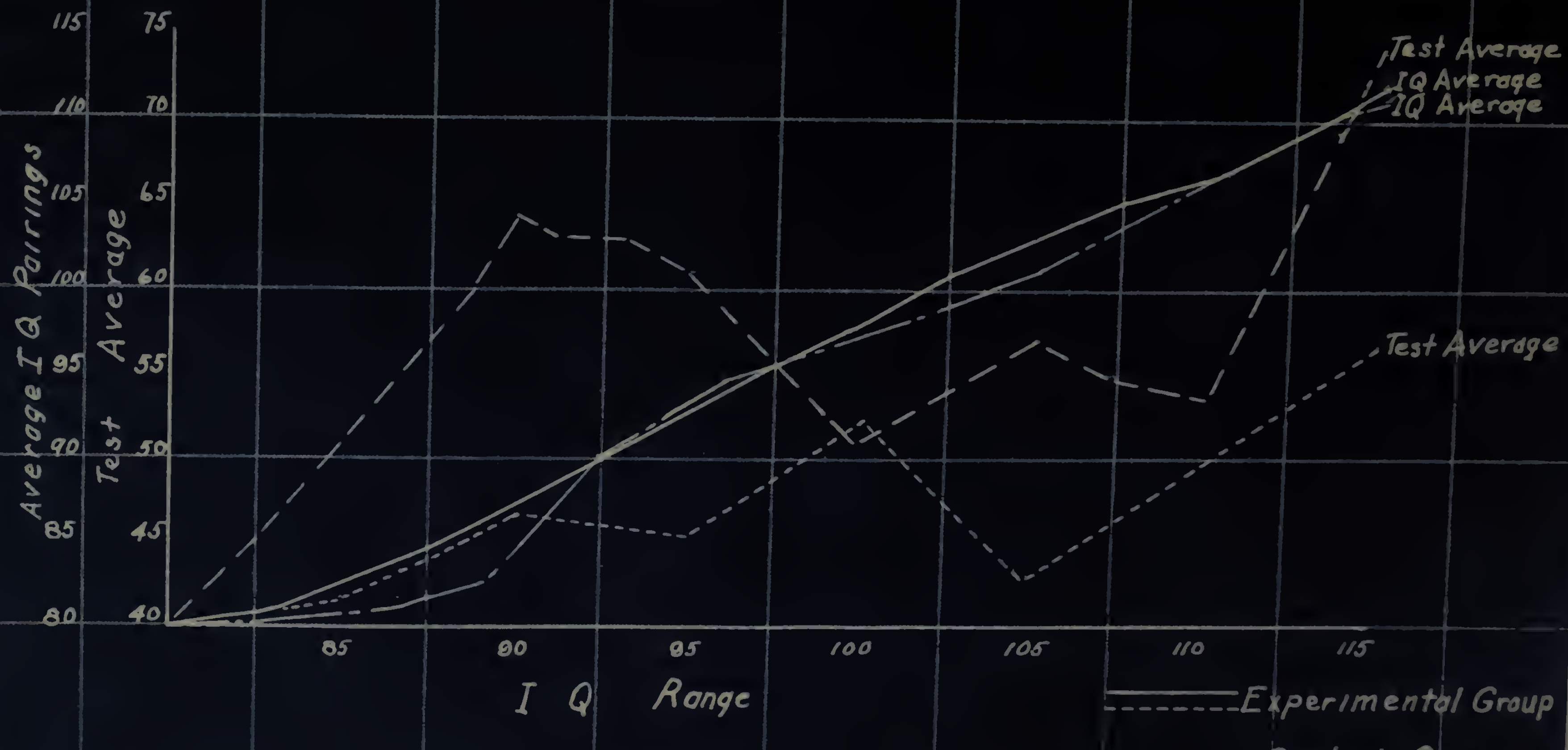
GROUP PAIRINGS
AVERAGES FOR IQ AND TEN TESTS

EXPERIMENTAL GROUP (WITH NOTEBOOKS) NAME	IQ	AVE	IQ	CONTROL GROUP (WITHOUT NOTEBOOKS) NAME	IQ	AVE
			110-115			
L.C.	118	60.5		B.C.	114	54.4
K.F.	114	58.0		H.C.	111	89.6
B.W.	110	61.5		F.J.	110	82.5
D.W.	110	56.2		M.L.	113	50.7
G.R.	111	52.6		M.W.	110	98.1
N.R.	110	53.4		D.R.	110	80.5
	673	342.2			668	455.8
AVE...	112.1	57.03			111.3	75.13
			105-110			
A.J.	107	41.8		W.E.	106	49.9
B.C.	108	43.8		M.W.	106	75.4
A.E.	106	58.0		R.H.	108	35.0
D.G.	106	56.5		R.K.	107	57.0
	427	200.1			427	217.2
AVE---	106.7	50.02			106.7	54.32
			100-105			
G.F.	101	37.6		B.E.	100	43.7
O.A.	102	52.3		B.J.	100	35.7
R.F.	103	22.1		D.G.	102	49.3
S.H.	105	51.0		F.R.	103	64.1
R.W.	105	39.6		L.W.	103	61.6
S.D.	103	55.7		S.R.	103	68.6
	621	258.3			610	343.0
AVE---	103.5	43.05			101.6	57.38
			95-100			
B.R.	96	71.5		B.A.	98	49.6
D.H.	96	51.5		L.R.	99	61.7
C.W.	99	34.8		Z.T.	96	43.5
	291	157.8			293	154.8
AVE---	97.0	52.60			97.6	51.60
			90-95			
D.R.	93	52.6		A.G.	92	61.9
E.R.	92	70.0		B.W.	92	70.6
M.J.	94	25.1		C.N.	92	45.0
S.U.	93	34.8		T.R.	95	71.6
	372	182.5			371	249.1
AVE---	93.0	45.62			93.6	61.51
			80-90			
M.H.	85	47.8		B.J.	81	60.0
S.H.	88	45.1		P.W.	86	68.0
	173	92.9			167	128.0
AVE----	86.5	46.45			83.5	64.00

TABLE VIII

GENERAL SUMMARY OF IQ AND TEST AVERAGES

	EXPERIMENTAL GROUP AVERAGE (WITH NOTEBOOKS)		CONTROL GROUP AVERAGE (WITHOUT NOTEBOOKS)	
IQ RANGE	IQ AVERAGE	TEST AVERAGE	IQ AVERAGE	TEST AVERAGE
110-115	112.1	57.03	111.3	75.13
105-110	106.7	50.02	106.7	54.32
100-105	103.5	43.05	101.6	57.38
95-100	97.0	52.60	97.6	51.60
90-95	93.0	45.62	93.6	61.51
80-90	86.5	46.45	83.5	64.00
TOTALS	598.8	294.77	594.3	363.94
GENERAL AVE	99.8	49.12	99.0	60.15



Results I Q and Test Averages

PART VI

TABULATION AND INTERPRETATION OF MATERIAL

TABULATION AND INTERPRETATION OF MATERIAL.

The material on the effect of using notebooks and workbooks in the teaching of Physics is presented in this chapter as pointed out before, ten informal teacher-made tests were administered at intervals throughout the experiment and the conclusions of the study was based on theresults of these tests. Each test marks the completion of one unit of work and each unit of work will be treated in turn. The outline of the units and the tests used may be found in the appendix.

TEST UNITS

(1) UNIT 1 ARCHIMEDES' PRINCIPLE.

The main topic in this unit was Archimedes' Principle. The results on the test on this unit are found in Table IX. The Experimental Group developed knowledge of this principle of Physics by means of the notebook; the Control Group did no notebook work whatever.

The mean for the Experimental group was 40.6 while the mean for the Control group was 44.9 . The Critical Ratio of this difference is .6 Before a difference can be depended upon as reliable, the Critical

Ratio should be at least as large as 3.0 * The Critical Ratio inthis unit is so small that we can say rather definitely that there is no proved difference between these groups in favor of or against using the notebook method of teaching Archimedes' Principle.

(2) UNIT 2 MOMENTS OF FORCE

The main topic for this unit was the Moments of Force. The results on the tests on this unit are found in Table X . The mean for the Experimental group was 49.8 ; that of the Control group 62.0 The Critical Ratio of this difference is 2.84 This Critical Ratio shows a distinct tendency to favor the Control group or those not using the notebook. The chances are 99.7 out of 100 that the Control group achieved significantly more. This difference, however, is not large enough to be conclusive by convention.

(3) UNIT 3 RESULTANT AND EQUILIBRANT FORCES

The chief topic for this unit was the Resultant and Equilibrant Forces. The results on the tests on this unit are found in Table XI . The mean for the Experimental group was 50.2 while the mean for the Control group was 63.4 The Critical Ratio of this difference is 2.39, a figure not large enough to guarantee a real

* Garrett H.E. "Statistics in Psychology and Education"

significance in favor or against the use of the notebook in teaching the Resultant and Equilibrant Forces. The Critical Ratio 2.39 indicates that there were 99.3 chances in 100 that whatever difference may be present was significant in favor of the Control group.

(4) UNIT 4 EQUILIBRIUM

This unit dealt with the principle of Equilibrium where the sum of the clockwise forces equals the sum of the counter-clockwise forces. The results on the test of this unit are found in Table XII. The mean for the Experimental group was 50.4 while the mean for the Control Group was 54.0. The Critical Ratio of the difference is .78 .This Critical Ratio, as in test one, is so small that we can say with definite assurance that there is no proved difference between these groups in favor or against the use of the notebook method of teaching Equilibrium. It also indicates that there were 78chances in 100 that the difference was greater than zero.

(5) UNIT 5 THE CENTER OF GRAVITY

The Center of Gravity where all the weight of a body seems to be centered was the subject matter of unit five. The results on the test on this unit may be found in Table XIII .

TABLE IX

SCORES MADE BY THE TWO GROUPS ON TEST ONE TOGETHER WITH THE MEANS AND CRITICAL RATIO

PUPIL NO	EXPERIMENTAL GROUP (WITH NOTEBOOK)	CONTROL GROUP (WITHOUT NOTEBOOK)
1	30	60
2	80	70
3	100	80
4	48	40
5	60	100
6	60	80
7	32	0
8	18	0
9	40	0
10	40	0
11	20	40
12	24	50
13	20	30
14	40	50
15	48	40
16	40	70
17	80	0
18	20	20
19	0	0
20	20	40
21	30	70
22	20	30
23	20	50
24	20	50
25	20	20
MEANS	40.6	44.9
STANDARD DEVIATION	22.0	28.0
STANDARD ERROR MEANS	4.4	5.6

STANDARD ERROR OF DIFF. OF MEANS 7.1
CRITICAL RATIO OF DIFF. OF MEANS .6

TABLE X

SCORES MADE BY THE TWO GROUPS ON TEST 2 TOGETHER WITH THE MEANS AND CRITICAL RATIO

PUPIL NO.	EXPERIMENTAL GROUP (WITH NOTEBOOK)	CONTROL GROUP (WITHOUT NOTEBOOK)
1	43	44
2	80	86
3	50	78
4	49	96
5	53	77
6	51	80
7	38	51
8	20	78
9	60	40
10	58	75
11	43	52
12	58	76
13	36	68
14	21	91
15	53	55
16	66	66
17	71	46
18	66	63
19	13	83
20	40	59
21	61	86
22	31	35
23	38	71
24	48	48
25	66	65
MEANS	49.8	62.0
STANDARD DEVIATION	15.0	15.8
STANDRAD ERROR OF MEANS	3.0	3.1

STANDARD ERROR OF DIFF. OF MEANS 4.29
CRITICAL RATIO OF DIFF. OF MEANS 2.84

TABLE XI

SCORES MADE BY THE TWO GROUPS ON TEST 3 TOGETHER WITH THE MEANS AND CRITICAL RATIO

PUPIL NO	EXPERIMENTAL GROUP (WITH NOTEBOOK)	CONTROL GROUP (WITHOUT NOTEBOOK)
1	58	55
2	50	85
3	90	95
4	60	85
5	28	55
6	53	98
7	45	45
8	15	70
9	70	0
10	55	70
11	38	80
12	53	55
13	50	40
14	53	65
15	65	75
16	53	65
17	60	25
18	40	70
19	30	55
20	45	60
21	58	60
22	10	20
23	40	65
24	23	55
25	45	95

MEANS	50.2	63.4
STANDARD DEVIATION	3 6.7	22.0
STANDARD ERROR OF MEANS	3.3	4.4
STANDARD ERROR OF DIFF. OF MEANS	5.5	
CRITICAL RATIO OF DIFF. OF MEANS	2.39	

TABLE XII

SCORES MADE BY THE TWO GROUPS ON TEST 4 TOGETHER WITH THE MEANS AND CRITICAL RATIO

PIPUL NO	EXPERIMENTAL GROUP (WITH NOTEBOOK)	CONTROL GROUP (WITHOUT NOTEBOOK)
1	80	20
2	45	80
3	45	35
4	50	100
5	60	45
6	45	35
7	40	60
8	25	45
9	55	50
10	60	65
11	35	45
12	50	70
13	75	55
14	54	60
15	40	65
16	40	80
17	55	50
18	55	70
19	35	55
20	50	60
21	85	50
22	45	40
23	50	70
24	75	50
25	50	55
MEANS	50.4	54.0
STANDARD DEVIATION	14.4	17.9
STANDARD ERROR OF MEANS	2.88	3.58

STANDARD ERROR OF DIFF. OF MEANS 4.59

CRITICAL RATIO OF DIFF. OF MEANS .78

The mean for the Experimental group was 28.4 . The mean for the Control group was 51.2. The Critical Ratio of this difference is 3.62 . This Critical Ratio being greater than 3 shows a reliability of a proved difference between these groups in favor of the Control group in teaching the principle of the Center of Gravity. It indicates further that there were 100 chances in 100 that the difference was significant.

(6) UNIT 6 SIMPLE MACHINES THE INCLINED PLANE

The main topic of this unit was the Inclined Plane. The results on the test on this unit are found in Table XIV . The mean for the Experimental group was 60.4 while the mean for the Control group was 68.4. The Critical Ratio of this difference is 1.40 . Again this difference is too small to definitely say that there is any proved difference between these groups in favor or against using the notebook method of teaching the Inclined Plane. A 1.40 Critical Ratio indicates also that there were 92 chances in 100 that the difference was greater than zero.

TABLE XIII

SCORES MADE BY THE TWO GROUPS ON TEST 5 TOGETHER WITH THE MEANS AND CRITICAL RATIO.

PUPIL NO.	EXPERIMENTAL GROUP (WITH NOTEBOOKS)	CONTROL GROUP (WITHOUT NOTEBOOKS)
1	50	50
2	25	95
3	40	85
4	40	100
5	45	40
6	20	85
7	75	50
8	30	80
9	50	50
10	20	70
11	20	0
12	0	30
13	0	60
14	0	70
15	0	0
16	25	60
17	40	50
18	25	0
19	25	24
20	50	55
21	45	50
22	0	45
23	20	70
24	0	60
25	40	40
MEANS	28.4	51.2
STANDARD DEVIATION	18.3	25.6
STANDARD ERROR OR MEANS	3.66	5.12
STANDARD ERROR OF DIFF.OF MEANS	6.29	
CRITICAL RATIO OF DIFF.OF MEANS	3.62	

TABLE XIV

SCORES MADE BY THE TWO GROUPS ON TEST 6 TOGETHER WITH THE MEANS AND CRITICAL RATIO

PUPIL NO	EXPERIMENTAL GROUP (WITH NOTEBOOKS)	CONTROL GROUP (WITHOUT NOTEBOOKS)
1	65	60
2	80	100
3	70	90
4	75	100
5	75	0
6	50	93
7	0	40
8	70	90
9	85	50
10	82	70
11	25	50
12	76	80
13	40	50
14	75	70
15	60	76
16	68	72
17	89	80
18	74	70
19	40	50
20	70	70
21	90	93
22	30	70
23	40	75
24	70	80
25	70	75
MEANS	60.4	68.4
STANDARD DEVIATION	20.8	20.1
STANDARD ERROR OF MEANS	4.16	4.02
STANDARD ERROR OF DIFF. OF MEANS	5.7	
CRITICAL RATIO OF DIFF. OF MEANS	1.40	

(7) UNIT 7 WORK, POWER AND ENERGY

Work, Power and Energy are included in the subject matter for unit seven. Test results on this unit are found in Table XV . The mean for the Experimental group was 49.6 while the mean for the Control group was 52.8 . The Critical Ratio of this difference is .44 . This Critical Ratio is so small that it may be definitely stated that there is no proved difference between these groups in favor or against using the notebook method of teaching Work, Power and Energy. The Critical Ratio indicates further that there were 66 chances in 100 that the difference was greater than zero.

(8) UNIT 8 HEAT CHARLES' LAW

This unit has for its main topics Heat and Charles' Law. The results on the test on this unit are found in Table XVI. The mean for the Experimental group was 56.4 The mean for the Control group was 69.6 . The Critical Ratio of thisdifference is 3.47 . Since this Critical Ratio is greater than 3 there is evidence that a reliability of a proved difference exists between these groups in favor of the Control group in teaching

TABLE XV

SCORES MADE BY THE TWO GROUPS ON TEST 7 TOGETHER WITH THE MEANS AND CRITICAL RATIO.

PUPIL NO.	EXPERIMENTAL GROUP (WITH NOTEBOOK)	CONTROL GROUP (WITHOUT NOTE BOOK)
1	45	30
2	70	95
3	45	85
4	90	100
5	65	50
6	40	80
7	50	80
8	50	50
9	70	0
10	70	0
11	40	30
12	50	50
13	0	40
14	50	40
15	0	75
16	70	60
17	80	60
18	60	90
19	40	0
20	60	50
21	0	65
22	0	40
23	30	60
24	45	40
25	40	85
MEANS	49.6	52.8
STANDARD DEVIATION	24.8	26.6
STANDARD ERROR OF MEANS	4.96	5.32
STANDARD ERROR OF DIFF. OF MEANS	7.2	
CRITICAL RATIO OF DIFF. OF MEANS	.44	

TABLE XVI

SCORES MADE BY THE TWO GROUPS ON TEST 8 TOGETHER WITH THE MEANS AND CRITICAL RATIO.

PUPIL	EXPERIMENTAL GROUP (WITH NOTEBOOKS)	CONTROL GROUP (WITHOUT NOTEBOOKS)
1	76	70
2	65	95
3	55	90
4	50	100
5	50	70
6	75	82
7	60	63
8	75	85
9	50	50
10	60	75
11	40	60
12	72	80
13	0	50
14	75	70
15	50	75
16	70	76
17	80	65
18	65	80
19	50	50
20	58	75
21	85	75
22	50	50
23	40	75
24	65	70
25	50	75
MEANS	56.4	69.6
STANDARD DEVIATION	16.0	11.1
STANDARD ERROR OF MEANS	3.20	2 .22
STANDARD ERROR OF DIFF.OF MEANS	3.8	
CRITICAL RATIO OF DIFF.OF MEANS	3.47	

Heat and Charles' Law. The Critical Ratio indicates that there were 100 chances in 100 that the difference between these groups was significant.

(9) UNIT 9 HEAT OF FUSION OF ICE

Heat of Fusion of Ice was the main topic of unit nine. The results on the test on this unit are to be seen in Table XVII. The mean for the Experimental group was 56.0 . For the Control group the mean was 70.8 . The Critical Ratio of this difference is 3.67 . This Critical Ratio being greater than 3 shows that a reliability of proved difference exists between these groups in favor of the Control group in teaching this unit of Heat of Fusion of Ice. It further indicates that there were 100 chances in 100 that the difference between the two groups was significant.

(10) UNIT 10 HEAT OF VAPORIZATION

In the tenth test Heat of Vaporization was the main topic for consideration. In Table XVIII will be found the results on the test on this unit.

TABLE XVII

SCORES MADE BY THE TWO GROUPS ON TEST 9 TOGETHER WITH THE MEANS AND CRITICAL RATIO.

PUPIL NO.	EXPERIMENTAL GROUP (WITH NOTEBOOKS)	CONTROL GROUP (WITHOUT NOTENOOKS)
1	78	70
2	66	95
3	60	92
4	50	100
5	50	70
6	70	85
7	40	68
8	65	90
9	50	65
10	60	75
11	50	60
12	70	76
13	0	60
14	72	60
15	40	75
16	70	72
17	80	70
18	60	84
19	55	45
20	68	70
21	86	75
22	45	60
23	40	75
24	60	72
25	60	80
MEANS	56.0	70.8
STANDARD DEVIATION	16.5	11.6
STANDARD ERROR OF MEANS	3.30	2.32
STANDARD ERROR OF DIFF.OF MEANS	4.03	
CRITICAL RATIO OF DIFF.OF MEANS	3.67	

The mean for the Experimental group was 55.6 . That of the Control group was 66.0 . The Critical Ratio of this difference is 1.92 . This Critical Ratio is so much below the required figure for reliability that we may definitely state there is no proved difference between these groups in favor or against using the notebook method of teaching Heat of Vaporization. It indicates also that there were 97 chances in 100 that the difference was greater than zero.

(11) TOTAL SCORES OF THE TEN TESTS

Since the Critical Ratios of the ten tests varied so widely the difference cannot be depended upon as reliable without a picture of the Critical Ratio of the total scores of the ten tests. The results of these ten tests are shown on Table XIX. The mean for the Experimental group was 484.0 while that of the Control group was 608.8 . The Critical Ratio of the difference is 3.20 . This Critical Ratio indicates a significance in favor of the Control group or those not using the notebook. It further indicates that there were 100 chances in 100 that the Control group achieved significantly more.

TABLE XVIII

SCORES MADE BY THE TWO GROUPS ON TEST TOGETHER WITH THE MEANS AND CRITICAL RATIO

PUPIL NO.	EXPERIMENTAL GROUP (WITH NOTEBOOKS)	CONTROL GROUP (WITHOUT NOTEBOOKS)
1	75	85
2	70	95
3	60	95
4	50	100
5	40	60
6	70	85
7	38	40
8	70	90
9	50	45
10	60	70
11	65	60
12	70	20
13	0	40
14	70	65
15	40	80
16	75	65
17	80	50
18	50	70
19	60	30
20	65	80
21	90	80
22	40	60
23	30	75
24	72	73
25	30	90
MEANS	55.6	66.0
STANDARD DEVIATION	19.4	19.7
STANDARD ERROR OF MEANS	3.88	3.94
STANDARD ERROR OF DIFF. OF MEANS	5.44	
CRITICAL RATIO OF DIFF. OF MEANS	1.92	

TABLE XIX

TOTAL SCORES MADE BY THE TWO GROUPS ON THE TEN TESTS TOGETHER WITH THE MEANS AND CRITICAL RATIO

PUPIL NO.	EXPERIMENTAL GROUP (WITH NOTEBOOK)	CONTROL GROUP (WITHOUT NOTEBOOK)
1	605	544
2	580	896
3	615	825
4	562	981
5	526	501
6	534	805
7	418	499
8	438	754
9	580	350
10	565	570
11	376	437
12	523	557
13	221	493
14	510	641
15	396	616
16	557	686
17	715	496
18	515	617
19	348	435
20	526	619
21	700	706
22	251	450
23	348	716
24	478	600
25	451	680
MEANS	484.0	608.8
STANDARD DEVIATION	121.4	152.0
STANDARD ERROR OF MEANS	24.28	30.40
STANDARD ERROR OF DIFF. OF MEANS	38.9	
CRITICAL RATIO OF DIFF. OF MEANS	3.20	

PART VII

CONCLUSION

CONCLUSION

Summary of Results

In the light of these statistics we may definitely conclude that the method of teaching Physics by the substitute plan of using problems is moderately superior to the method of using laboratory notebooks.

A Critical Ratio at least as large as 3 is necessary before a difference can be depended upon as reliable. The following list shows the Critical Ratio together with the corresponding units and tests.

UNIT	C.R.	TEST
1	.6	ARCHIMEDES' PRINCIPLE
2	2.84	MOMENTS OF FORCE
3	2.39	RESULTANT AND EQUILIBRANT FORCES
4	.78	EQUILIBRIUM
5	3.62	CENTER OF GRAVITY
6	1.40	INCLINED PLANE
7	.44	WORK POWER ENERGY
8	3.47	HEAT -CHARLES' LAW
9	3.67	HEAT OF FUSION OF ICE
10	1.92	HEAT OF VAPORIZATION
11	3.20	TOTAL SCORES

Three of the tests namely ; Center of Gravity , Heat and Charles' Law, and Heat of Fusion of Ice had Critical Ratios of 3.62 , 3.47 and 3.67 respectively. In these cases the difference can be depended upon as reliable in favor of the Control group. Moments of Force and Resultant and Equilibrant Forces show Critical Ratios of 2.84 and 2.39 . While these Critical Ratios are not large enough to be depended upon as reliable they are significant in favor of the Control group. Two tests namely Heat of Vaporization and The Inclined Plane show Critical Ratios of 1.92 and 1.40 respectively. These figures definitely are not reliable but whatever difference there may be present is in favor of the Control group. The three remaining tests: Equilibrium, Work-Power-Energy, and Archimedes' Principle had respective Critical Ratios of .78 , .44 , and .6 all of which show no reliable difference.

The Critical Ratio of the Total Scores was 3.20 . This figure shows a difference that is reliable and permits us to state definitely that there is significance in favor of the Experimental group of those who used the substitute method of teaching Physics.

PART VIII

RECOMMENDATIONS

ACKNOWLEDGMENTS

VITA

RECOMMENDATIONS

In view of the statistical findings it would seem advisible to provide an outlet for the scientific interests that every boy possesses. This may be done in the school workshop after school hours or in the home workshop. Finished work could then be brought into school and demonstrated before the class. The writer would recommend that one period per week be devoted to such activity.

> Colvin says- "In physics pupils may construct scientific apparatus for their own use, or for the use of the class or school. One of the most enthusiastic classes in this subject that the writer has observed, partly made and entirely installed an outfit in wireless telegraphy." *

The aim of science teaching should be to develop individual initiative. The following objectives will assist greatly in reaching this goal.

1 To develop hobbies and provide opportunity to indulge in the manipulation of tools, machines and measuring devices.

2 To make pupils able to read scientific articles more intelligently and with greater interest.

3 To provide an opportunity for individual parttticipation in classroom activities through pupil demonstrations.

4 To stimulate a spirit of investigation and invention.

* Colvin - Introduction to High School Teaching Ch IV P75

Fortunately in the teaching of laboratory science in most high schools what may be termed " original experiments " are seldom given. In this respect ....there should be less formal work in physics and more actual investigation on the part of the pupil."*

Mr. Charles R. Allen of the Technical High School, Springfield, Mass., conducted an investigation along these lines over one semester and he found that the class devoting one period a week to the demonstration of scientific activities showed better grades than three other classes not included in this program.

The following list shows the wide range in which Mr. Allen's class was interested.

Automobiles
Aviation
Boats
Cartesian Diver
Civil Engineering
Dam Construction
Deep Sea Diving
Dirigibles
Electric Motors
Electricity
Gas Engine
Diesel Engine
Household Appliances
Illusions
Magnetism
Projection Machine
Refrigeration
Radio
Steam Engine
Storage Batteries
Submarine
Telegraph
Telephone
Telescope
Theater Lighting

*Colvin - Introduction to High School Teaching. Ch. 13 p.285

To satisfy the ever present, dormant pupil interests it would seem advisable to recommend that space be provided where pupils could retire after school and, under supervision, stimulate these interests and also their spirit of investigation . Add to this frequent visits to local factories and institutions where new ideas may be introduced and where the principles of physics may be pointed out.

The writer feels that such a program is quite in harmony with the findings which this thesis presents.

ACKNOWLEDGMENTS

The author wishes to acknowledge with sincere thanks and gratitude the cordial help and genuine interest shown him by his thesis committee consisting of Professor Winthrop S. Welles ; Dr Richard W.Fessenden; and Professor Orton L. Clark.

The writer is also deeply indebted to Dr. Albert W. Purvis for his patience and helpfulness in the interpretation of the statistics involved.

The author wishes to thank Maj. Burton A. Adams Principal of Technical High School, Springfield, Mass., and Dr. Charles A. Cockayne, Head of the English Dept., of the same school for their kindness and interest.

Finally to my sister for her kindness in typing this thesis .

VITA

1908-1911	University of Rochester AB 1911
1912-1915	South River High School, South River, N.J.
1915-1916	Industrial School, Shirley, Mass.
1916-1921	Metallurgical Laboratory, Springfield Armory Springfield, Mass.
1921-1931	Trade School, Springfield, Mass.
1931 -	Technical High School, Springfield, Mass.

BIBLIOGRAPHIES

BIBLIOGRAPHY

1 Elmer W. Cressman
Workbook vs Oral Instruction
J of Ed. Soc. 7 Dec. 1933 250-53

2 Clayton L Nelson School Rev. 46 Jan. 1938 17-31
The Development and Appraisal of Workbooks in the Social Sciencies. R.M. Tyron (cited)

3 Edger Bruce Wesley Workbooks in the Social Studies.
Historical Outlook Apr. 1931 151-53

4 Cecillia J. Allen So this is the Workbook
Eng. J May 1933 p.380

5 Fred G. Wolcott Problems of the Workbook
Eng. J Sept 1933 p.574

6 George A, Motter Teacher Assignments vs Workbook Assignments. School Rev. Jan. 1939.

7 A.C.Monahan Some Comments from Science Teachers and Others. Sc. Sci. and Math.
31: 569-73 May 1931

8 P.E. Knight How Valuable is Mary's Notebook.
Eng. J (H.S. ed) 22: 57-9 Jan.1933

9 H.E. Kilander Status of the Sciences as Entrance Subjects in the Colleges of Liberal Arts.
Soc. Sci. and Math . 31: 569-73 May 1931

10 A.W.Hurd What are the High School Boys add Girls Getting from their Courses in Science ?
Teachers Col. Rec. 31 : 642-6 Apr. 1930

11 L.E. Hildebrand Humanizing Science Teaching
Sch. Sci. and Math. 3o: 922-24 Nov.1930

12 E.R.Means How Shall Laboratory Work be Presented ?
H. Sch. 7:87-9 Mar. 1930

13 N.LeConte and F.H.Edmister Individual Laboratory vs Demonstration Method. H.Sch J 14 ; 445 -Dec 1931

14 H.E.Wise Are High School Sciences Meeting the Challenge?
Neb. Ed. J 16 : 380- Nov 1936

15 C.G. Frazier Class book in Science Classes.
Sch . (Sec Ed.) 24: 779-83 May 1936

16 R.C.Woods Notebook as an Educational Devise.
Peabody J of Ed. 12: 118-19 Nov. 1934

17 M.G.Crumby Our Children use Notebooks.
Science Ed. News 3o: 39 Sept. 1934

18 E. Haworth What shall be the Program for the Jr. and
Sr. High School ? Nat. Ed. Assn. 1932 470-1

19 M. Stolenback Interesting Notebooks.
Prac. Home Ec. 9: 16 Jan. 1931

20 More Valuable Notebooks. Ind. Arts and Voc. Ed.
19: 266 July 1930

21 S.S.Colvin Introduction to High School Teaching
Macmillan Co. 1918

BIBLIOGRAPHY

(Not embodied in this thesis)

1 Laboratory Techniques of Teaching . Planning the Individualization of instruction. By the Members of Education 335-336 M 1937-1938 Introduction by Briggs N.Y. Teachers College Columbia Univ. 1938 p.82

2 Elliott R. Downey A Comparison of the Lecture-Demonstration and the Laboratory Method of Instruction in Science. School Rev. Nov. 1925 Vol. 33 pp688-97

3 Bibliography of Science Teaching in Secondary Schools. U.S. Bureau of Education Bulletin Nov 13 1925

4 A.W.Hurd Tendencies Disclosed By Curriculum Investigation in Higher Education and their Implications for Science Teaching in Elementary and High Schools. Sci. Ed. 21: 147-51 Oct 1937

5 F.D. Curtis Diagnosis and Remedial Treatment in the Field of Science. Biblog. National Society for the Study of Education. 34 th yearbook p 331-45

6 P.B.Sharpe Why not use Control Experiments ? Sci. Ed. 22: 19-22 Jan. 1938

7 W.C.Croxton Major Aims in Science Teaching. Sci. Ed. 19: 149-52 Dec 1938

8 H.S. Shelton New Type of Science Teaching. Contemporary Rev. 150 : 598-604 Nov. 1936

9 M. Stolzenback Home Economic Notebooks, an Evaluation of their Worth as a Teaching Device . Prac. Home Econ. 14: 338 Nov 1935

10 G.W.Peterson and H.R.Douglas Published Workbook vs Pupil made Notebooks in 9th Grade Science Biglog. Sch. Rev.43: 608-13 Oct 1935

11 E.M. Johnson Method of Providing for Retarded Pupils in General Science. Nat. Ed. Assn. Proc. 1937 381-2

BIBLIOGRAPHY

(continued)

12 G.Eby Science for Non-College Students.
Sec. Ed. 6: 12-15 Jan 1937
excerpts Nat. Ed. Assn. Proc. 1936 357-8

13 C.S.Webb Teaching the Advanced Science using
the Demonstration Method. Sch. Sc. and Math.
38: 20-8 Jan. 1938

14 Otis W. Caldwell Reorganization of Science in
the Secondary Schools. U.S. Bureau of Ed.
Bulletin No.26 1920 62 pp

15 General Science in Grades 7 and 8. Biology in
Grade 9, Junior High School. Course of Study
Monograph No.2, Public Schools of Denver
Colorado 1924 77pp.

16 Benjamin C. Gruenberg Unifying the Aim of
High School Science Teaching . School and Society
Jan. 31 1925 Vol. 21 pp 121-129

17 Clayton H. Howe What 80 Teachers Think as to the
Aims and Subject Matter of General Science
Gen. Sci. Quart. Vol. 2 1918 pp 445-58

18 George W. Hunter The Place of Science in the Secondary School. Sch. Rev. May-June 1925
Vol. 33 pp 370-381 453-466

19 Paul Numberger Objectives of Natural Science.
Sch. Sci. and Math.
Dec. 1925 Vol.25 pp 927-36
Jan. 1926 Vol.26 pp 33-43

20 A Textbook in the Principles of Science Teaching.
The Macmillan Co. 1917 486 pp

21 General Science Instruction in the Grades. Contributions to Education No.4 George Peabody
College for Teachers. Nashville 1921 105 pp

BIBLIOGRAPHY

(continued)

22 * National Educational Association of the United States
1201 16th St. Northwest Washington D.C.

23 * Cooperative Study of Secondary School Standards.
744 Jackson Place Washington, D.C.

* Institutions assisting in furnishing references

BIBLIOGRAPHY

Workbook References

1 Adams, Imogene, and Cole, R.D. An Analysis of Algebra Workbooks. Journal of Educational Research 26: 116-31 Oct. 1931

2 Courtis and others. The Workbook, Curriculum Journal 6: 1-49 ; Apr. 1935 Cleveland; Society for Curriculum Study (Western Reserve University). Selected Bibliography. p-45-49

3 Elliott, A.W. This Workbook Craze. School Executive Magazine 51 : 19-20, 38; Sept 1931.

4 Gates Arthur L. Place of the Workbook in Teaching Reading School Executive Magazine. 50: 365-67 ; Apr. 1931

5 Gates , Arthur L. The Workbook in Practice. School Executive Magazine. 51; 349-50, 387 ; Apr. 1932.

6 Goodrich T.V. Is the Workbook a Necessity or a Luxury ? School Executive Magazine . 50: 359-61 ; Apr. 1931.

7 Harrington N.E. and Lippert D.E. Workbook: What do people in the Teaching Profession Think of It ? Pennsylvania School Journal. 82; 359-62 Mar.1934.

8 Hurd A.W. The Textbook vs the Work Sheets in Instruction. Ed. Adm. and Superv. 17; 661-64 Dec. 1931

9 Hurd A.W. The Workbook as an Instructional Aid. Sch. Rev. 39: 608-16 ; Oct 1931

10. McGuire. E. Teacher, Pupil and Workbook. School Executive Magazine. 54: 46-47 Oct 1934

11 Maxwell, C.R.Workbook a Recent Development. American School Board Journal. 88: 16, 44, 46; Mar. 1934

12 Miller, E.C. A New Hazard for Teachers. Illinois Teacher 19 : 306; Apr. 1931. Also in other journals of state education associations during March, April and May , 1931

13 Osborn, W.J. Educational Medicine. Educational Research Bulliten 10: (Ohio State University) 19-20 January 7, 1931.

BIBLIOGRAPHY

Workbook References

(continued)

14 Rice H.H. Are We Making Blank Fillers out of Students. School Executive Magazine. 51: 329 Mar. 1932

15 Sharp R.A. The Use and Abuse of Workbooks. High School Teacher 9: 13-14 ; Jan.1933.

16 Van Liew, C.C. Can the Workbook be Justified School Executives Magazine. 53: 38-39 Oct. 1933. Excerpts School Management . 3: 22 Jan. 1134.

17 Wesley E.B. Workbooks in the Social Studies. Historical Outlook 22: 151-53 Apr. 1931.

18 Wilson H.E. Worksheets as Aids in Supervised Study. Historical Outlook. 20: 287-91 ; Oct 1920

19 Mead, Vera Olbert What abilities are stressed in Workbooks in History School Review Apr. 1932 pp284--89

NATIONAL EDUCATION ASSOCIATION OF THE UNITED STATES
1201 Sixteenth Street, Northwest, Washington, D.C.

Research Division Additional References July 1938

REFERENCES ON SCIENCE

I. List of Outstanding Committee Reports Affecting the Curriculum in the Sciences, Published since 1890 .

1. Beauchamp, Wilbur L. Instruction in Science. U.S. Dept of the Interior, Office of Education, Bulletin, 1932, No.17 National Survey of Secondary Education, Monograph No.22 Washington , D.C. : Government Printing Office, 1933. 63 p 10 ¢

2. National Education Association, 1201 Sixteenth Street, N.W., Washington, D.C.

A. American Association of School Administrators (formerly the Department of Superintendence).

1. Development of the High School Curriculum. Sixth Yearbook. Washington, D.C. : the Association,1928. Chapter 16, "Research in High School Science," p. 344-59. $2.00 .

2. The Junion High School Curriculum. Fifth Yearbook. Washington , D.C.: the Association, 1927. Chapter 10, "Junior High School Science, " P.147-81 $2.00.

3. The Nation at Work on the Public School Curriculum. Fourth Yearbook. Washington, D.C.: the Association 1926. Chapter 4, "Elementary Science and Nature Study" p. 59-112. $2.00 .

4. Research in Constructing the Elementary School Curriculum. Third Yearbook, Washington, D.C.; the Association, 1925. Chapter 9. "Elementary Science ," p. 297-302 (Out of print)

b. Commission on the Reorganization of Secondary Education. Reorganization of Science in Secondary Schools . U.S. Dept. of the Interior, Bureau of Education, Bulletin, 1920 No. 26, Washington, D.C.; Government Printing Office, 1920. No.26. Washington,D.C. : Government Printing Office,1920 62 p. 10¢

c. Committee of Ten on Sedondary School Studies. Report. New York; Publishedfor the National EducationaAssociation by the American Book Co., 1894. Report of the Conference on Physics, Chemistry, and Astronomy,P. 117-37.

3. National Society for the Study of Education. A Program for Teaching Science. Thirty-First Yearbook , Part I Bloomington, Ill.: Public School Publishing Co.,1932 370 p

References on Science (continued)

II. General References

4. Beauchamp, Wilbur L., Compiler. "Selected references on Secondary-School Instruction ; Science ." School Review 46 : 140-42 ; February 1938 (Annual compilation)

5. Beauchamp, Wilbur L. ; Curtis, F.D. ; and Powers, R.S. "Special Methods and Psychology of the Elementary-School Subjects; Science. " Review of Educational Research 7: 508-509, 567 ; December 1937 . $ 1.00.
See also Reviews of Educational Research for October and December 1931 and February 1935.

6. Bruce, G.V., Compiler. "Elementary School Science References and Instructional Materials." Science Education 19: 25-29, 76-78, 172-77; February, April, and December 1935. 20: 78-82; April 1936 . 21: 31-34: February 1937.

7. Caldwell, Otis W., and Lundeen. G.E. Experimental Study of Superstitions and other Unfounded Beliefs as Related to Certain Units of General Science. New York: Teachers College, Columbia University, 1932. 138 p.

8 . Carpenter, Harry A. "Class Programs: Seventh -Grade Science; with Discussion." Education on the Air. (Edited by J.H.MacLatchy.) Seventh Yearbook, Institute for Education by Radio. Columbus, Ohio: Ohio State University Press, 1936 . p. 140-54.

9. Craig, Gerald S. Certain Techniques Used in Developing a Course of Study in Science for Horace Mann Elementary School. Contributions to Education, No. 276. New York: Teachers College, Columbia University, 1927. 73 p.

10. Craig, Gerald S. New Science Program for Elementary Schools. New York: Teachers College, Columbia University 1934. 30 p

11. Croxton, W.C. Science in the Elementary School. New York; McGraw-Hill Book Co., 1937 . 454 p.

12. Curtis, Francis D. "Curriculum Investigations; Science." Review of Educational Research 7: 162-65, 219 ; April 1937. $1.00
See also Reviews of Educational Research for January 1931 and April 1934.

13. Curtis, Francis D. "Diagnosis and Remedial Treatment in the Field of Science". Educational Diagnosis. Thirty - Fourth Yearbook, National Society for the Study of Education. Bloomington, Ill. ; Public School Publishing Co., 1935 P 331-45

14. Curtis, Francis D. Digest of Investigations in the Teaching of Science in the Elementary and Secondary Schools. Philadelphia; P. Blakiston's Son and Co., 1926. 341 p.

15. Curtis Francis D. Second Digest of Investigations in the Teaching of Science. Philadelphia; Blakiston's Son and Co., 1931. 424 p.

16. Curtis, Francis D. A Synthesis and Evaluation of Subject-Matter Topics in General Science. Boston: Ginn and Co., 1929. 83 p.

17. Downing, Elliott R. Introduction to the Teaching of Science; a Revision of Teaching Science in the Schools . Chicago: University of Chicago Press, 1934. 258 p.

18. Downing, Elliott R. Teaching Science in the Schools . Chicago; University of Chicago Press, 1925. 185 p

19. Dunn, Fannie W. "Natural Sciences in the Modern Rural School." Newer Types of Instruction in Small Rural Schools. Yearbook, 1938. Washington, D.C.: Dept of Rural Education, National Education Association, 1938. p.73-86. 50¢

20. Efron, Alexander. Teaching of Physical Sciences in Secondary Schools of the United States, France, and Soviet Russia. Contributions to Education, No. 725. New York: Teachers College, Columbia University 1937. 296 p.

21. Fitzpatrick, Frederick L. Science Interests. New York: Teachers College, Columbia University, 1936. 72 p.

22. Frank, Joseph Otto. How to Teach General Science. Philadelphia: P.Blakiston's Son and Co., 1926. 240 p.

23. Frutchey, Fred P., and Tyler, R.W. "Examinations in the Natural Sciences." Construction and Use of Achievement Examinations; a Manual for Secondary School Teachers. (Edited by H.E. Hawkes and others.) Report of the American Council on Education. Boston: Houghton Mifflin Co., 1936 . p. 214-63.

24. Glenn, Earl R., and Walker, Josephine, compilers. Bibliography of Science Teaching in Secondary Schools. U.S. Dept. of the Interior, Bureau of Education, Bulletin 1925, No. 13. Washington, D.C.: Government Printing Office, 1925. 161 p. 20¢

25. Haupt, George W. Experimental Application of a Philosophy of Science Teaching in an Elementary School. Contributions to Education, No.633. New York: Teachers

College, Columbia University, 1935. 109 p See also: Science Education 18: 234-38 ;December 1934.

26. Holy, Thomas C., and Sutton, D.H. List of Essential Apparatus for Use in High School Sciences. Columbus, Ohio: Ohio State University, 1931. 32 p.

27. Hunter, George W. Science Teaching at Junior and Senior High School Levels. New York: American Book Co., 1934 . 552 p.

28. Klopp, W.J. Relative Merits of Three Methods of Teaching General Science in the High School. Chicago: Central Association of Science and Mathematics Teachers , 1930. 82 p.

29. Langvick, Mina M., and Noll, Victor H. U.S.Government Publications Useful to Teachers of Science. Cicrular No. 48. Washington, D.C. : Office of Education, U.S. Dept. of the Interior, March 1932. 20 p. (Mimeo.) Gratis.

30. McSpadden, Warren W., compiler. "Selected References on Elementary-School Instruction; Science." Elementary School Journal 38: 214-17; November 1937. (Annual compilation.)

31. Maxwell, Paul A. Cultural Natural Science for the Junior High School; Objectives and Procedures. Baltimore: Willaims and Wilkins Co., 1932.

32. Meister, Morris. The Educational Value of Certain After-School Materials and Activities in Science. New York : A.M. Porter and Co., 1931.

33. National Society for the Study of Education. International Understanding through thePublic-School Curriculum. (Edited by I.L. Kandel and Guy M.Whipple.) Thirty-Sixth Yearbook, Part II . Bloomington, Ill.; Public School Publishing Co., 1937. Chapters 18,19, and 20, p. 156-92.

34. Powers Samuel R. "Psychology and Methods in the High School and College: Science." Review of Educational Research 8: 60-66 , 97-98 ; February 1938. $ 1.00.
See also Review of Educational Research for December 1931, February 1932 and December 1934.

35. Preston, Carleton E. High School Science Teacher and His Work. New York: McGraw-Hill Book Co. 1936 272 p.

36. Slavson, S.R., and Speer, R.K. Science in the New Education as Applied to the Elementary School. New York: Prentice-Hall, 1934. 396 p.

37. "Symposium: The Need for a Twelve-Year Science Program for American Public Schools." Science Education 22; 51-75 ; February 1938.

38. West, Joe Y. Technique for Appraising Certain Observable Behavior of Children in Science in Elementary Schools. Contributions to Education, No.728. New York; Teachers College, Columbia University, 1937. 118 p.

39. Woodring, Maxie Nave, and others. Enriched Teaching of Science in the High School. New York; Teachers College, Columbia University, 1928 . 374 p.

Additional references may be found in the Education Index, published by the H. W. Wilson Co., New York City, which is available in many public and school libraries. The following magazines are also fruitful sources of information:

1. American Physics Teacher. Published for the American Association of Physics Teachers by the American Institute of Physics, 175 Fifth Ave., New York, N.Y.

2. Journal of Chemical Education. 20th and Northampton Sts., Easton, Pa.

3. Nature Magazine. American Nature Association, 1214 Sixteenth St,, Washington, D.C. See also: Palmer, Ephraim L. Nature Magazine's Guide to Science Teaching. Washington, D.C. ; American Nature Association, 1936 128 p.

4. Popular Science Monthly. 353 Fourth Ave., New York, N.Y.

5. School Science and Mathematics. 3319 N. 14th St., Milwaukee, Wis.

6. Science. Grand Central Terminal, New York, N.Y.

7. Science Education. 525 W. 120th St., New York,N.Y.

8. Science Guide for Elementary Schools. State Department of Education, Sacramento, Calif.

9. Science News Letter. Science Service, 2101 Constitution Ave., Washington, D. C.

10. Scientific American. Munn and Co., Inc., 24 W. 40th St., New York, N.Y.

APPENDIX

Outline of Units

Unit 1 - Archimedes Principle

I Inspiration

Hiero King of Syracuse
Eureka
Lifting a stone in water

II Preparation

Why boats float
Immersing a stone in a graduate of water
Holding a cork under water and releasing it

III Recall material needed in past experiment

Weight
Volume

IV Explanation

Experiment performed
Development of Principle
Verification of Principle

V Application

Problems
Uses

VI Examination

Testing

VII Correlation

TEST No 1

Archimedes' Principle

1. (a) State Archimedes' Principle

   (b) Define buoyancy.

2. Mechanical advantage may be found in the following three ways

M.A.= M.A. = M.A.=

3. A machine carries a load of 2 tons with an effort of 200 lbs.

   Find M.A.

4. The small piston of an hydraulic press is 2" ; the large one is 36". Find M.A.

5. 300 lbs is applied to the small piston of an hydraulic press. The small piston measures 4" in diameter and the large piston has a diameter of 60". Find the load this machine will carry.

6. A machine carries a load of six tons with an effort of 2oo lbs. If the area of the small piston is 8 sq. inches what must be the area of t e large piston ?

7. E = 500 lbs.

   R = 20000 lbs.

   Diameter of small piston = 3"

   Find the diameter of the large piston.

Unit 2 - Moments of Force

I Inspiration

Wheel turning on axle
Throwing a base ball
A crowbar
Expanding steam
Magnetic attraction

II Preparation

Motion in a straight line
Motion about an axis
The clock (hands)
Magnitude of force
Center of moments-fulcrum
Equilibrium

III Recall of material needed

Positive and negative values
Multiplication

IV Explanation

Set up in equilibrium
Two unequal forces
Two unequal moment arms
Units of force
Experiment performed
Development
Verification

V Application
Problems
Where found?
Uses

VI Examination

Testing

VII Correlation

Test No 2

Forces (A) Moments

I. Define the following:

(a) A force
(b) A moment arm
(c) The center of moments
(d) A moment of force

2. Forces tend to do two things viz:

I........................

2........................

3. A force of 100 lbs 5' from the fulcrum is just as effective as 50 lbs ....feet from the fulcrum.

4. What is the difference between weight and mass ?

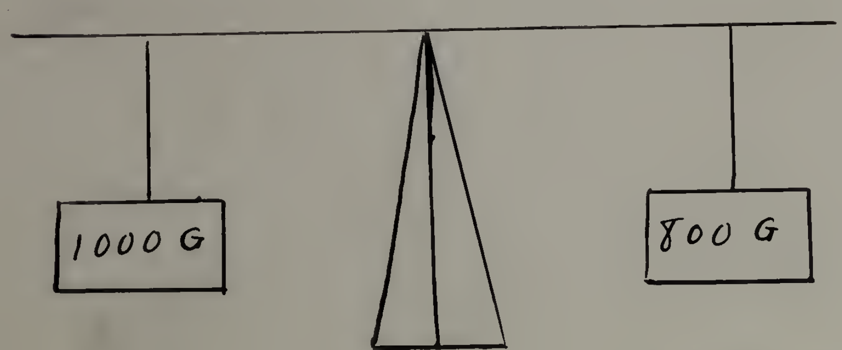
5. State Newton's Law of Gravitation.

6. Give the units by which forces are measured.

7. In measuring forces what is the significance of the figures 32.16 and 980

8. Why does the gravitational pull show a different intensity at the equator, Springfield, the north pole?

9. Referring to question I label the following sketch



Unit 3 - Resultant & Equilibrant Forces

I Inspiration

- Forces of nature
- Aeroplane
- Steam shovel
- Rockets
- Gravitation
- Newton

II Preparation

- Two boys pulling a rope
- Board display of 3 forces at a point
- Sun, moon, earth

III Recall of material needed

- Weight vs Mass
- Metric system
- Square root
- Units of force

IV Explanation

- Experiment performed
- Right angle
- Acute angle
- Development
- Verification

V Application

- Problems
- Uses

VI Examination
- Testing

VII Correlation

Test No 3

Forces (B) Resultant and Equilibrant

1. A resultant is a diagonal, hypotenuse, an angle, a curved line, a straight line.

2. An equilibrant is one half, one third, equal to the resultant.

3. Define a force. Name three agents that produce forces.

   Name three forces that produce tint forces.

4. A single force that could produce the same effect as two or more forces acting together is called..........

5. One of the most important forces to man is called ... .

6. The units of force are

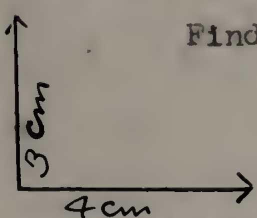
   (a) Metric ....

   (b) English..........

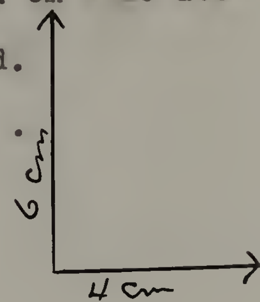
7. In the following problems the scale is 1 cm = 10 lbs

   Use the "Right Angle Triangle Method.

   Find Resultant and Equilibrant .

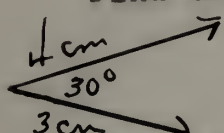


Scale
1cm = 10 Lbs

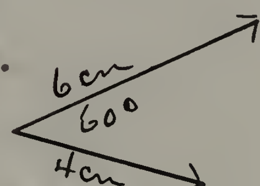


8. Use the same scale as in problem No.7.

   Find the Resultant and equilibrant.



Scale
10cm = 10 LBS



   Give reason for different lengths of "R"

Unit 4 - Equilibrium

I Inspiration

Tug- of -War
See-Saw
Platform balance
Early automoblies
Toys

II Preparation

School building	(base)	
Smcke stack	(base)	
Clockwise	)	moments
Counter clockwise	)	
Funnel	(3 positions)	

III Recall of material needed

Moments of force
Center of moments

IV Explanation

Experiment performed
Clockwise vs counter clockwise forces
Development
Verification

V Application

Problems
Applications
Uses

VI Examination
Testing

VII Correlation

Test No 4

Forces (C) Equilibrium

I From your own observation and experience state five cases in which parallel forces operate.

2 Two or more parallel forces are in equilibrium when..

....

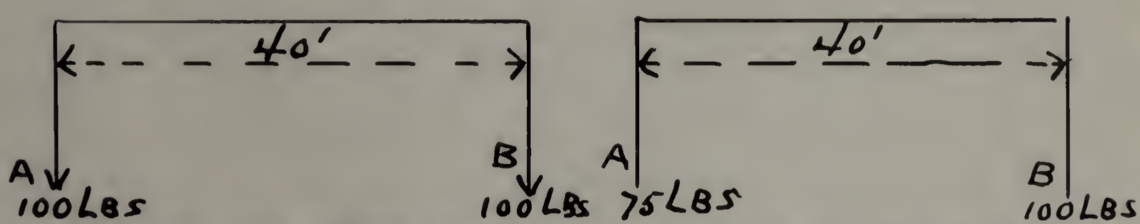
3 What force which takes the place of two or more forces is called ....

4 The resultant of two parallel forces in the same direction is equal to.................. and in the .... direction.

5 To produce equilibrium twokinds of motion must be prevented

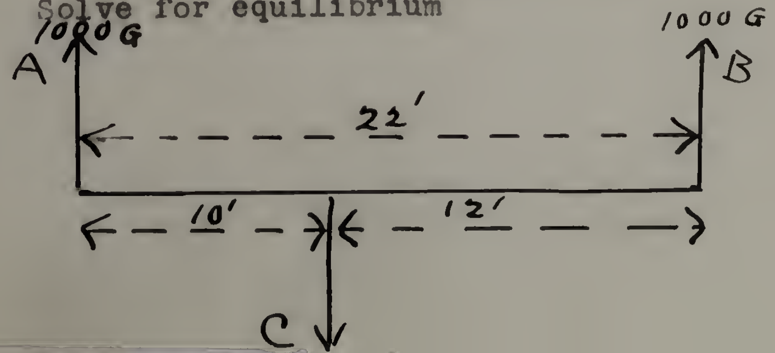
(a) ....
(b) ....

6 Indicate in each case where force must be placed to produce equilibrium



7 Is C in the right position to produce equilibrium?

Solve for equilibrium



8 Compute the forces of the two piers of a bridge 50 feet in length due to a truck weighing 6000 lbs. The truck is ten feet from one end.

Unit 5 - Center of Gravity

I Inspiration

Balance a meter stick having 500 g weight on one side and no weight on the other

Salt Shaker)
Toys) self righting

II Preparation

Compare early automobile with the modern type for tipping
Ballast on an ocean liner
Stability of Pyramids
Stability of Radio Transmission Tower

III Recall of material needed

Center of moments
Moments of Force
Clockwise and counter clockwise Forces

IV Explanation

Experiment performed
Development
Verification

V Application

Problems
Uses

VI Examination

Testing

VII Correlation

Test No 5

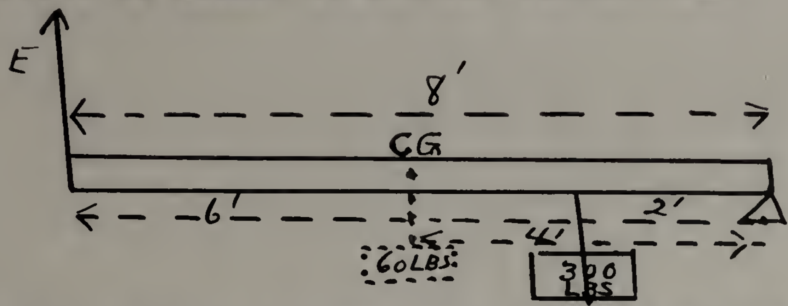
Center of Gravity

I. By the term " Center of Gravity" I mean ....

....

2. Does the weight of a lever assist the effort (E) or the resistance (R) ? Show by sketch.

3. In the following problem the weight of the lever is 60 lbs. Solve this problem by showing how much effort is needed to produce equilibrium.



4. A wedge shaped log 12' long weighing 75 lbs can be balanced by itself at a point 4' from the heavy end.

(a) Where should the fulcrum be placed if 2 boys sitting on the ends and weighing 80 and 45 lbs respectively are to be balanced.

(b) What weight is supported by the fulcrum ?

(c) Make a sketch and label properly.

5. A body may be in one of three states of equilibrium

They are 1...................
2...................
3...................

6. Why do some objects right themselves when tipped over ?

Give examples.

7. When is an object said to be stable ?

When is an object said to be unstable?

Unit 6 - Inclined Plane

I Inspiration

- Early man and his tools
- More and better machines with an increase in knowledge of physics
- Locating inclined planes in the school shops
- Grades - Higways - Railroads
- Ramps

II Preparation

- Compare "input " and " output" of a machine
- Mechanical advantage
- Efficiency
- Which is easier ; to lift a load directly or use an inclined plane ?

III Recall of material needed

- Simple mathematics

IV Explanation

- Experiment performed
- Development
- Verification
- Law of Inclined Plane

V Application

- Problems
- Uses

VI Examination

- Testing

VII Correlation

Test No 6

Inclined Plane

1. State the simple machines in the inclined group.

2. There are two ways of finding the mechanical advantage of an inclined plane.

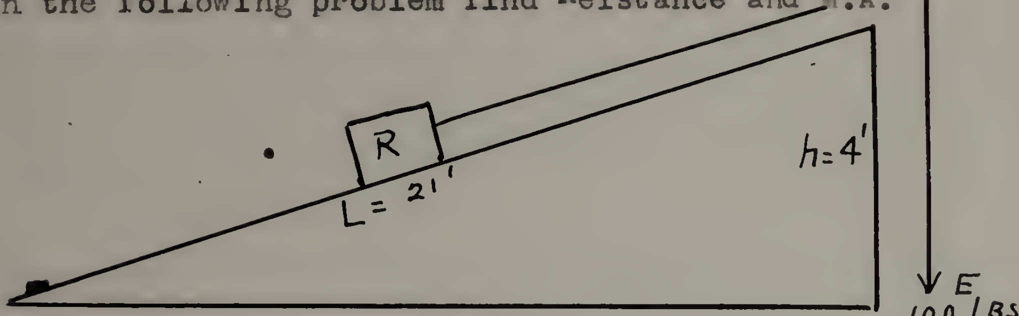
    (a) M.A. =

    (b) M.A. =

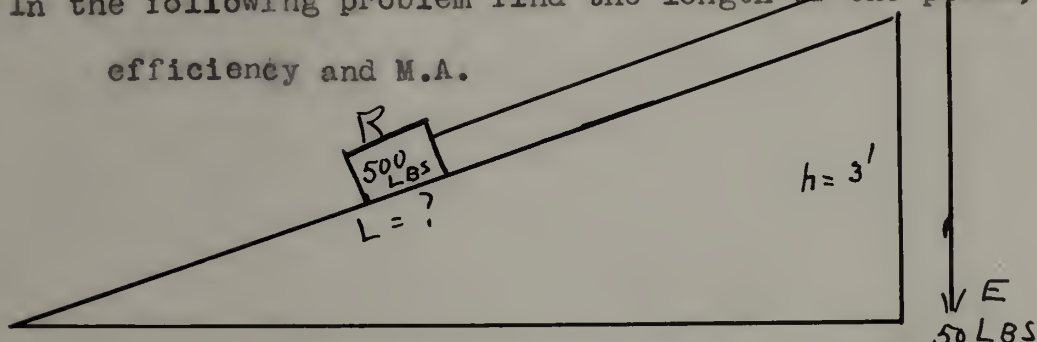
3. State the Law of the Inclined Plane.

4. Recalling to mind the lathe and the milling machine select five parts from each machine that makes use of the inclined plane.

5. In the following problem find Reistance and M.A.



6. In the following problem find the length of the plane, efficiency and M.A.



7. What is the least force required to roll a 250 barrel up an incline 25' long and 5'high ?

Unit 7 - Work - Power - Energy

I Inspiration

Niagara Falls
Dynamite, TNT, Gasoline, Coal
James Watt
Pile Driver
Gigantic cranes

II Preparation

How much work did a boy do climbing the school stairs ?
What horse power ?
What factors does work include ?
What factors does power include?
What factors does energy include ?
Dragging vs lifting
Units of measurements

III Recall of materials needed

Force
Friction

IV Explanation

Experiments performed
Development
Verification

V Application

Problems
Uses
Transformations
Conservation

VI Examination

Testing

VII Correlation

Test No 7

Work - Power - Energy

1 Define work, power and energy.

2 In measuring work what two factors are involved ?

3 State the gravitational and absolute units of work.

4 A barrel of sugar is to be placed from the ground to a truck. The barrel of sugar weighs 396 lbs. Is it easier to lift it directly or to use a plank ? State reasons and use formula.

5 Define power and give the formula for finding power.

6 State the units of power both in the CGS system and the FPS system.

7 Who first gave us the term horsepower and what does it mean ?

8 1 kilowatt = ...watts
1 Horsepower = ...watts
1Horsepower = ...kilowatts
The Watt = one ....per sec.

9 Each person in a city uses 5 gallons of water per day , The population is 300 000. A gallon of water weighs about 8 lbs, How much H.P. would be needed to lift the water 200 feet in one day ?

10 Define energy.

State the kinds of energy.

Give the formulae for finding energy.

II What is meant by the terms " conservation of energy" and "transformation of energy " ?

12 Find the potential energy of a cubic yard of water at the top of Niagara Falls 168' high .

13 A projectile weighing 1000 lbs moves with a velocity of 2500 feet per second . Find the kinetic energy in foot pounds ; in f ot tons.

Unit 8 - Heat - Charles' Law

I Inspiration

Railroad tracks
Bridges
Oven thermometers
Air in Automobile tire
Effects produced by heat
Charles 1787
Gay-Lussac

II Preparation

Expansion of materials
(a comparison)
Compound bar
Absolute Temperature
Heat units
Expansion and density
Formulae

III Recall of material needed

Boyles Law
Volume
Density

IV Explanation

Experiment (demonstration)
Development
Verification

V Application

Problems
Uses
Force of Expansion
Bursting tires, broken wires,

VI Examination

Testing

VII Correlation

Test No 8

Heat - Charles' Law

1. State Charles' Law.

2. Solids .... when heated and ....when cooled.

3. Place in 1,2,3, order the expansibility of a gas, a solid and a liquid.

4. State Prevost's Law of Heat Exchange.

5. What are the units of heat ?
   Give both English and Metric values.

6. Define the following

   (a) Calorie
   (b) B.T.U
   (c) heat capacity
   (d) specific heat

7. How would find the number of calories involved in heat exchange?

8. At 25 degrees centigrade a volume of gas is 900 cc
   Find its volume at 29 degrees centigrade.

9. 300 grams of metal at 98 degrees centigrade are mixed with 526 grams of water at 20 degrees centigrade. The temperature rises to 26 degrees. Find the specific heat of the metal.

10. 1000cc of gas at 780mm pressure and 30 degrees centigrade is subjected to a change both in pressure and temperature. What valume will the gas assume at STP ?

Unit 9 - Heat of Fusion of Ice

I Inspiration

Snow balls
Glaciers sliding down valley
Refrigeration
Calories vs degrees
Tubs of water in vegetable cellar
Ice cream

II Preparation

Melting and Freezing points
Volume and Solidification
Water pipes
Type metal
Crystalization
Calories
Sublimation
Law of heat exchange

III Recall of material needed

Solids, liquids, gases
Volumes
Pressure
Conservation of energy

IV Explanation

Demonstration
Development
Verification

V Application

Problems
Uses

VI Examination
Testing

VII Correlation

Test No 9

Heat of Fusion

1. Define Fusion. Fusion has two other common names, State them.

2. Clarify these terms :

   Melting point
   Boiling point
   Solidification
   Crystaline
   Plastics

3. What is meant by the term " Heat of Fusion" ?

4. How would you proceed to find Heat of Fusion ?

5. When one gram of ice at zero degrees centigrade is changed to one gram of ice water at zero degrees centigrade ....calories are involved.

6. A calorimeter weighing 100 grams has a sp.Gr. of .09; it contains 400 grams of water at 40 degrees centigrade; 91 grams of dry ice are introduced. When the ice is all melted the temperature is 18.2 degrees centigrade. What is the heat of fusion of ice ?

7. A glass tumbler has a sp. ht.of .02. It weighs 300 gm and has a temperature of 60 degrees centigrade. A certain amount of ice was added to the tumbler. The ice was all melted and the final temperature was 10 degrees. How many grams of ice were melted ?

8. 100 gm of ice at zero degrees centigrade are stirred in 400 gm of water at 60 degrees centigrade. Calculate the final temperature.

9. Why is ice a good refrigerant ?

On what principle is mechanical refrigeration based ?

How is it possible to get refrigeration from a gas flame ?

Is artificial ice made according to this principle ?

Unit 10 - Heat of Vaporization

I Inspiration

Artificial Ice
Mechanical refrigeration
Liquid air
Steam burn more severe than hot water burn
Cooling effects of fanning

II Preparation

Liquid changed to vapor
Calories involved
Cooling effect of evaporation
Distillation
Laws of Boiling

III Recall of materials needed

Law of Heat Exchange
Conservation of Energy
Solids, liquids, gases
Volumes

IV Explanation

Demonstration
Development
Verification

V Application

Problems
Uses

VI Examination

Testing

VII Correlation

Test No 10

<u>Heat</u> of <u>Vaporization</u>

1. Define the following :
    Evaporation
    Boiling
    Ebullition
    Sublimation
    True boiling point

2. State the conditions under which the rate of evaporation depends.

3. At 760mm pressure water will boil at .... degrees centigrade. Each degree change in temperature = ...mm pressure. Each mm change in pressure = ... degrees centigrade.

4. State the laws of boiling

5. Define "Heat of Vaporization "

6. 1 gm water at 100 degrees centigrade plus .... calories yields 1 gm steam at 100 degrees centigrade.

   When steam condenses to water how many calories are involved ? Are the steam and water the same temperature ?

7. A calorimeter has a sp. gr. of .09 and weighs 120gm; 401 gm of water at 6 degrees centigrade are put into the calorimeter ; 23.5 gm of steam are

allowed to enter the calorimeter and water; the final temperature of the water is 40 degrees centigrade. Find the heat of vaporization.

8. Find the heat of vaporization of water from the following data

Weight of calorimeter	80 gm
Weight of water	500 gm
Temperature of cold water	15 degrees C
Final temperature of mixture	29.3 degrees C
Weight of steam	12 gm

Approved by:

W. H. Welles

Orton L. Clark

R. W. Fessenden

Thesis Committee

Date May 24, 1939